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EXAMINER

KIELIN, ERIK J

| ART UNIT | PAPER NUMBER |
|----------|--------------|
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2813

DATE MAILED: 08/06/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/754,926

Applicant(s)

AHN ET AL.

Examiner

Erik Kielin

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 05 May 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 2,3,5,6,8-10,31 and 32 is/are pending in the application.
- 4a) Of the above claim(s) none is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 2,3,5,6,8-10,31 and 32 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 5 May 2003 has been entered.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 10, 2, 3, 5, 6, 8, 31, and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 5,923,056 (Lee et al.) in view of the basic text of Vossen and Kern, Thin Film Processes II, Academic Press: Boston, 1991, pp. 80-81, 108-109, 113-115, 188, 200 and JP 60-167352 A (Fujisada).

Regarding independent claim 10, Lee discloses forming a variety of semiconductor devices including MOS, flash EPROM, capacitors, DRAMs, etcetera (i.e. "an assembly" comprising a doped metal oxide, which may be a silicon-doped porous aluminum oxide (col. 1, line 66 to col. 2, line 10; col. 3, lines 19-40; col. 4, first paragraph) comprising:

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an exemplary method disclosed at cols. 5-6, "EXAMPLE 1", wherein the silicon-doped aluminum oxide layer **18** is formed on a semiconducting material ("silicon wafer **110**") by sputtering (i.e. evaporating) from a target containing aluminum with 1% silicon (i.e. evaporating silicon and aluminum) in a chamber having argon and oxygen, wherein sputtering/evaporation is generated by glow discharge plasma;

the evaporated silicon and aluminum react with oxygen to form evaporated silicon oxide and aluminum oxide, which mix and deposit as silicon-doped porous aluminum oxide **18** on the silicon semiconductor wafer **110**; and

forming a conductive material (called the "gate **13**" in **Lee**) over the insulating layer silicon-doped porous aluminum oxide **18**, the conductive material **13** being separated from the semiconductive material **110** by the silicon-doped porous aluminum oxide layer **18**. (Figs. 1 and 2).

Lee does not disclose that specifically silicon monoxide and aluminum oxide in the form of sapphire are evaporated from separate sources, but does expressly state that the doped metal oxide films, such as the exemplary silicon-doped aluminum oxide film, may be formed using "a conventional deposition technique such as sputtering ..." (col. 2, lines 15-21).

The basic textbook of **Vossen and Kern** teaches conventional techniques for forming thin films including forming a mixed or alloy film using "two-source sputtering, with one source for one alloy component and the other source for the second component." (See p. 200, section entitled "*Targets*.") **Vossen and Kern** also teaches numerous examples of mixed composition films formed using separate evaporative sources on pages 108-109, Table II which form a vapor mixture to form the mixed composition layer made from the separate evaporative sources.

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Sources for aluminum oxide (Al_2O_3) and SiO are also taught to be known on pages 113-115, Table III, as well as the composition of the vapor upon evaporation of a given source. Note in pertinent point that even if SiO_2 is used as the evaporative source, that SiO is the main component of the vapor -- not SiO_2 . So even if SiO_2 is thermally evaporated, SiO is the vapor species formed.

It would have been obvious to one of ordinary skill at the time of the invention to use a silicon monoxide source and an aluminum oxide source to form a silicon doped aluminum oxide film as a matter of design choice because the choice of SiO and Al_2O_3 sources are well known and will result is the same silicon-doped aluminum oxide as that disclosed in **Lee**, and because **Lee** teaches "a conventional deposition technique such as sputtering" will work, and because the use of separate sources to form a mixed or alloy layer is conventional, as taught by **Vossen and Kern**.

Applicant could overcome the rejection by providing evidence that the specific use of silicon monoxide and aluminum oxide provides unexpected results in the Si-doped aluminum oxide film relative to that source used in Lee. Presently there is no such evidence of record.

Then the only difference is that sapphire is not taught to be the aluminum oxide source.

Fujisada teaches the benefits of preventing injurious impurities from being incorporated into sputter-deposited aluminum oxide films by using a sapphire target, specifically for use in semiconductor device applications. (See Abstract.) Note that sapphire is necessarily single crystal because that which distinguishes aluminum oxide from sapphire is *only* the fact that sapphire is a single crystal of aluminum oxide.

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It would have been obvious to one of ordinary skill at the time of the invention to use a sapphire source as the aluminum oxide source in the method of **Lee** in view of **Vossen and Kern** to prevent contamination of the deposited film, as taught by **Fujisada**.

Regarding claim 2, the omission of O₂ is obvious since the oxygen component is already provided in the known SiO and Al₂O₃ sources. One of ordinary skill would be motivated to leave out the oxygen since it is already provided in the sources used.

Regarding claim 3, 5, and 6, **Lee** does not specifically indicate that the evaporation means is thermal evaporation, but **Vossen and Kern** teach the thermal evaporation is one of the art-recognized equivalent means of evaporating a source material to deposit a film. (See **Vossen and Kern**, p. 80, second sentence under section entitled "Evaporation Process.") **Vossen and Kern** also teach that evaporation is conventionally carried out using, *inter alia*, electron beams (guns) (pp. 80-81), and that ion beams are conventionally used for sputter deposition (p. 188).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use thermal evaporation, electron beams (guns), or ion beams as the method of evaporating sapphire, as taught by **Lee** in view of **Vossen and Kern** and **Fujisada**, because **Vossen and Kern** teach that each evaporation means is an art known means in which to evaporate a source to deposit a film. Moreover, there is no evidence of record that thermal evaporation provides some unexpected results relative to the other methods. Rather the evidence of record teaches away from any unexpected result since plural methods are indicated in the specification and claimed as being usable for evaporating the aluminum oxide source, whether it is sapphire or just aluminum oxide.

Regarding claim 8, **Lee** discloses the silicon substrate (col. 5, line 56).

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Regarding claim 31, **Lee** specifically states that the dopant is 0.1 to 30 weight percent of the dielectric film. (See Abstract.)

Regarding claim 32, **Lee** teaches an exemplary embodiment where the substrate temperature is 380 °C, but does not indicate that the semiconductor material is at room temperature during the deposition.

Vossen and Kern teach several examples of forming doped metal oxides using and SiO₂ target, for example, wherein the temperature range of the substrate is 25-300 °C. (See Table II.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to deposit the silicon-doped aluminum oxide of **Lee** at room temperature, because **Lee** teaches conventional sputtering methods may be used and **Vossen and Kern** teaches that sputtering at room temperature is conventional for doped oxide formation. Furthermore, it would be a matter of routine optimization to sputter deposit the silicon-doped aluminum oxide at room temperature because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. See *In re Jones*, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and *In re Boesch*, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious). One of ordinary skill would be especially motivated to use room temperature since **Vossen and Kern** teach that this temperature is conventional and in order to reduce the thermal budget which enables the production of smaller device features without fear of diffusion or damaging previously formed device features.

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4. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Lee** in view of **Vossen and Kern** and **Fujisada** as applied to claim 10, above, and further in view of **Wolf**, Silicon Processing for the VLSI Era, Vol. 1 : Process Technology, Lattice Press: Sunset Beach, CA 1986, p. 5.

Lee does not specifically state that the silicon substrate is “monocrystalline.”

Wolf teaches that integrated circuits are formed on monocrystalline or “single crystal” silicon substrates (p. 5, first paragraph under section entitled “Manufacture of Single Crystal Silicon.”)

It would have been obvious to one of ordinary skill at the time of the invention to use the notoriously well-known monocrystalline substrates as the silicon substrate of **Lee**, because **Wolf** teaches that monocrystalline is always used over other forms of silicon to enable sufficient carrier lifetime in semiconductor devices.

Response to Arguments

5. Applicant's arguments filed 5 May 2003 (Paper No. 20) have been fully considered but they are not persuasive.

Applicant argues the **Lee** does not disclose forming a silicon-doped porous aluminum oxide. Examiner respectfully disagrees. Applicant specifically recognizes that it is known in the art that the porous character of sputtered aluminum oxide to be associated with boundaries of columnar grains (instant specification p. 5, last paragraph). Similarly, **Lee** at col. 4, beginning at line 13, states that grain boundaries exist indicating pores exist. Moreover, **Lee** indicates that there exist “dangling bonds” (i.e. the absence of oxygen or pores) in the aluminum oxide film

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and that the silicon doping reduces --not eliminates-- such dangling bonds. Accordingly, Lee expressly teaches that the aluminum oxide film is porous and that the porosity is reduced by the silicon dopant. Accordingly, Applicant fails to recognize that the film formed by Lee is, indeed, porous.

Additionally, Lee is not required to teach the SiO and aluminum oxide target since these features are taught and/or suggested by the basic text of Vossen and Kern. Sapphire targets are taught by Fujisada to be purer than aluminum oxide. In this regard, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

US 6,579,767 B2 (Park et al.; col. 2, line 54 to col. 3, line 12), US Patent Application Publication 2001/0041250 (Werkhoven et al.; paragraph [0093]), and 6,541,079 B1 (Bojarczuk, Jr et al.; Abstract) each teaches formation of silicon-doped aluminum oxide films for gate insulators of transistors.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 703-308-4940. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Erik Kielin
Primary Examiner
August 4, 2003